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LABORATORY PRODUCTION OF THE MONARCH BUTTERLY, *Danaus plexippus*

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THERE IS NEED for monarch butterflies, *Danaus plexippus* (Linn.), for scientific and educational work. For these purposes equipment and methods for rearing the butterfly are being developed.

In the feld, in regions where the monarch occurs, in season, the butterfly is attracted to milkweeds for egg-laying. Plantings of *Asclepias curassavica* are especially useful for luring migrating butterflies to obtain them for experimental work. This plant is perennial and sub-tropical. In addition to milkweed flowers, the butterflies are attracted to many other kinds of flowers for their nectar.

In the laboratory the butterflies will drink from damp paper, water, and water to which honey has been added. Honey was added to the water at the rate of 1 teaspoon per cup of water. Crumpled paper toweling of a stiff variety or newspaper was placed in a shallow dish containing the solution. The butterflies would stand on, and drink from the damp paper.

Oviposition cage. An essential tool for rearing the butterfly is the oviposition cage. The cage used by the authors (Fig. 1) is 17 inches tall, 20½ inches wide, and 12 inches deep. The bottom is ½ inch plywood to which a wooden frame is attached. One side is provided with a terry cloth sleeve 6 inches in diameter and 10 inches long attached to wooden panel. Through this sleeve, butterflies, glass tumblers with water, cuttings of milkweed plants, and cut flowers can be passed without danger of butterflies escaping. The top, back, and one side of the cage are covered with muslin. The cloth at the back is in the form of a curtain, fastened at the top and weighted at the bottom with a piece of masonite ¼ by 3 by 20 inches. The masonite is held against the back of the cage by sheet-metal guides. The front of the cage is covered with glass or plexiglas.

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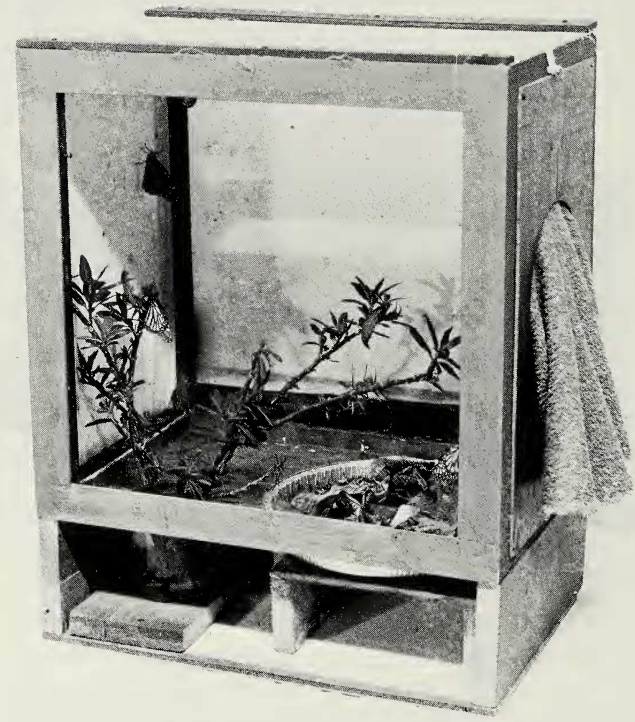

Fig. 1.—Oviposition cage.

When in operation, the cage contains a 9 by 1½ inch aluminum cake pan with honey-water and crumbled paper, a glass tumbler containing water and cuttings of milkweed, *A. currassavica*, and a number of egg-laying females.

Under the artificial conditions of the oviposition cage the butterflies will not always mate when they become mature. It is usually necessary to force-mate the butterflies by a method used by the workers at the University of Toronto, Canada, (Urquhart 1965).

Incubation of eggs. Eggs are laid almost exclusively on the leaves and stems of milkweed. Occasionally some eggs are laid on the damp paper, on the tumbler, or on the wood frame of the cage. The milkweeds are replaced with fresh plants every 1 to 3 days. Small parts of leaves and stems bearing 1 or several eggs are cut from the plants, placed in a pile on a piece of glass 4½ inches square, and covered for incubation with a clear, plastic cup 3½ inches in diameter and 3 inches tall (Fig. 2). A disposable cup of this size is obtainable from most retail liquor stores. Any number of eggs up to 100 may be incubated at one time under a cup. Humidity must be kept low enough to prevent the growth of mold, which seems to kill the eggs.

Rearing the caterpillars. When the eggs hatch, most of the larvae crawl up on the sides of the cup, now a cage, and rest for a time before they are ready to feed. At this time 1 or 2 milkweed terminals composed of 4 to 6 leaves each are placed in the cage, partly in contact with the plastic surface. Before long the caterpillars transfer to the milkweed and commence to feed. As the caterpillars grow and become crowded they are distributed among other cages. Three fifth instar caterpillars can be reared to maturity in 1 cage if they are of slightly different ages so that they do not interfere with each other when they are preparing to suspend themselves.

Storage of pupae. Pupae can be held in the cage until the butterflies emerge, or they can be removed and stored on a string rack. This rack is a wood frame with strings stretched horizontally 4 inches apart. A cardboard try beneath the strings is used to collect tachinid parasites issuing from suspended insects. Parasites may be present in larvae collected in the field, but not in laboratory-reared material.

The silk to which the pupae are attached will peel off the plastic surface if it is first started by rubbing with the finger or a rubber eraser. A mounting device is made of a 1½-inch long piece of ¾-inch masking tape. First, fold the masking tape at

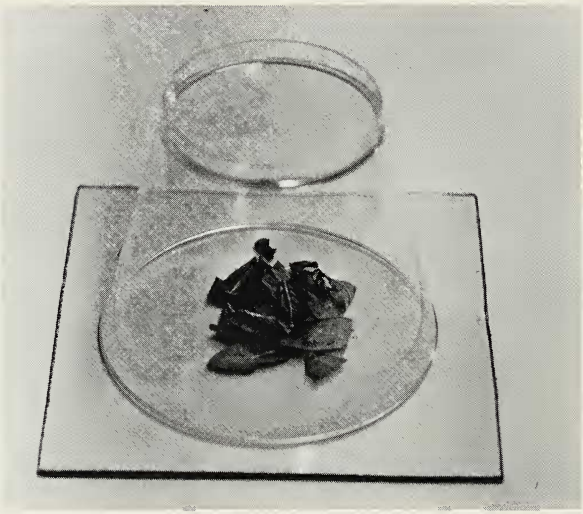

Fig. 2.—Plastic cup cage for incubating eggs and rearing small caterpillars.

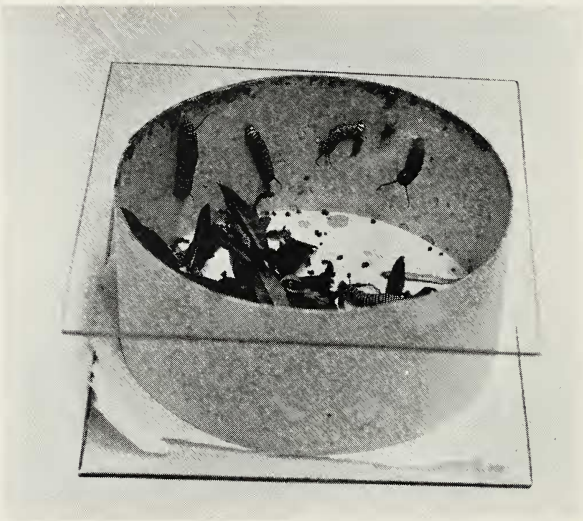

Fig. 3.—Cardboard cylinder rearing cage.

one end, lengthwise, half way. Then, place the silk of the pupa on the other end and press the adhesive surfaces together with the silk between. Th pupa can then be fastened to the string by a slanting cut in the folded tape or by folding ¼-inch of the tape over the string and securing it with a small paper clip. The pupa can then be identified by marking a number on the masking tape.

Cardboard rearing cage: A cage for rearing a larger number of fifth instar caterpillars to maturity per cage is composed of a cardboard cylinder 6 inches in diameter and 3 inches tall (Fig. 3). The top is a 7-inch square piece of glass or plexiglas. A 7-inch square piece of paper is laid on the bottom glass to absorb moisture and to keep the glass clean. The capacity of this cage is about 15 insects. When the caterpillars finish feeding, they crawl to the cover, form the silk button, and suspend themselves. Pupae suspended in this manner can be stored in a slotted wooden rack (Fig. 4). If desired, the pupae can be removed from the glass cover, either by scraping the silk off with a razor blade, or peeling it off wet. The insects can then be fastened to masking tape as described earlier. The removal of pupae from plexiglas is simpler. The silk peels off easily, dry.

It is more efficient to rear the larger number of caterpillars at one time, particularly if there is no virus disease (Urquhart, 1966 and Urquhart and Stegner, 1966) present. An advantage in rearing the smaller number of caterpillars in one cage is that if one insect is infected with the virus disease common to the monarch butterfuly, only 2 additional specimens are exposed. Also, the plastic cages are more easily sterilized without damage to them.

The caterpillars were reared in a dry, well-ventilated basement room with daylight, at about 74 degrees F. Under conditions of high humidity the silk may not adhere well to the plastic, but it never fails to stick to the glass.

Egg-production. An egg-production experiment was carried out in the Whittier College greenhouse from May 15 to June 27, 1968. The object of the experiment was to determine the egg-laying potential and longevity of butterflies which were fed on honey-water and flowers, and on honey-water alone. The frequency with which the butterflies feed on flowers in the field suggests that flowers might be necessary for the greatest egg-production in a cage.

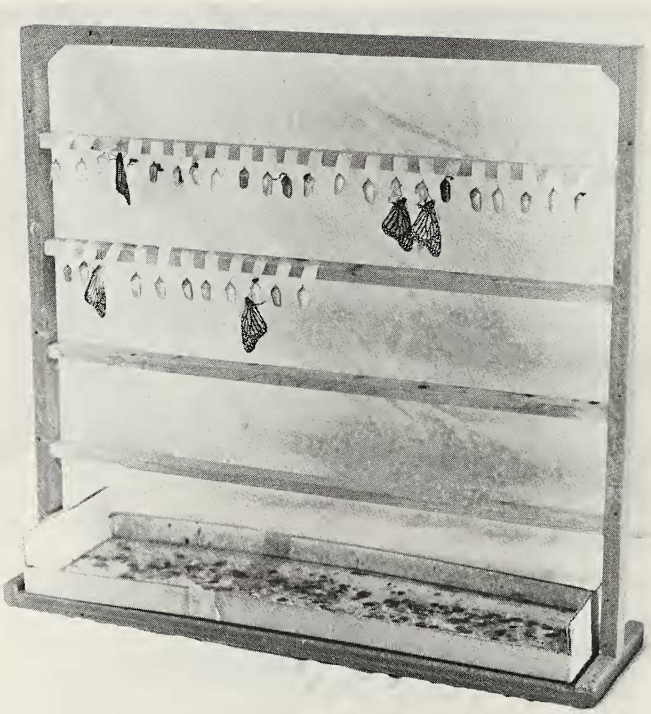

Fig. 4.—Wooden rack for storing and displaying suspended pupae.

The greenhouse is partially shaded by eucalyptus trees. The top ventilator was open continuously. Maximum and minimum temperatures F. were read on 26 and 25 days, respectively of the 43 days of the experiment. The maximum, minimum, and average temperatures for the maximum temperatures were 95, 74, and 82.2 degrees. The maximum, minimum, and average temperatures of the minimum temperatures were 67, 54, and 56.8 degrees.

The butterflies used in the experiment were reared from eggs which had been laid by a number of laboratory-reared butterflies.

TABLE 1. DATES BUTTERFLIES WERE MATED AND INTRODUCED INTO OVIPOSITION TEST CAGES.

Butterfly number	Date emerged	Date mated	Date transferred to cage: Honey-water and flowers	Date transferred to cage: Honey-water alone
1	May 10	May 16	May 15	
2	May 10	May 16		May 15
3	May 17	May 22	May 22	
4	May 17	May 22		May 22
5	May 18	May 23	May 23	
6	May 18	May 23		May 23
7	May 19	May 25	May 25	
8	May 19	May 25		May 25

TABLE 2. LONGEVITY AND EGG-PRODUCTION OF 8 BUTTERFLIES, 4 FED ON HONEY-WATER AND FLOWERS, AND 4 FED ON HONEY-WATER ALONE.

CONDITION

Honey-water and flowers			Honey-water alone		
Longevity		Total eggs	Longevity		Total eggs
Butterfly	Days		Butterfly	Days	
1	41		2	34	
3	37		4	40	
5	36		6	44	
7	35	1551	8	44	2365
Ave.	37.1	387.8		40.5	591.3

Procedure. Two oviposition cages were used with 4 force-mated butterflies distributed to each cage as shown in Table 1. Each cage contained honey-water and milkweed leaves. One cage contained, in addition, a separate tumbler with fresh-cut flowers—scabiosa, lantana, orange, milkweed, and other flowers. The flowers were attractive to the butterflies, and they were observed to feed on them frequently. The milkweed leaves, upon which the eggs were laid, were replaced with fresh leaves at from 1 to 3-day intervals, and the eggs counted. Tagged butterflies were used in the experiment. The longevity of each butterfly, therefore, was measurable, but it was not possible to determine the egg-production of the individual butterfly.

Results. The results of the experiment are shown in Table 2. The butterflies in the cage without the flowers laid 60.8 percent of all the eggs, an average of 591.3 eggs per butterfly. These butterflies lived an average of 40.5 days, 3.4 days longer than those with the flowers.

It is clear, contrary to what might be expected, that the flowers added nothing to the egg-laying ability of the butterflies. On the contrary, the flowers seemed to detract from the capacity of the butterflies to lay. A possible explanation of this result, suggested by Dr. Hovanitz, may be that time spent on the milkweed leaves may have been reduced by the attraction of the flowers. From a practical standpoint, it is convenient that flowers do not seem to be an advantage in egg-production.

The number of eggs laid by the butterflies with flowers was about equal to what Urquhart (1960) suggested might be expected to be laid under ideal conditions. He examined monarch ovaries and found more than 400 eggs.

Note: Seeds of *Asclepias curassavica* are available from Clyde Robin, P. O. Box 2091, Castro Valley, California, and from Pearce Seeds and Plants, Moorestown, New Jersey 08057.

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